Remarks

The claimed invention is directed to a method of synthesizing $LiFePO_4$ as a cathode material for a secondary battery. The present invention represents a substantial improvement over the prior art, in that it makes use of inexpensive, ordinary metal iron as a raw material, instead of expensive iron-containing compounds such as iron oxalate or iron acetate.

Claims 1-10 were in the application as originally filed. Claims 8 to 10 have been amended herein, and claim 4 has been cancelled. Therefore, claims 1-3 and 5-10 are pending. In addition, the specification has been amended to correct two obvious typographical errors.

It should be noted that, in claim 8, the term "at least" is intended to modify the term "partially melted," rather than the term "once." That is, the saccharide ... "gets at least partially melted once." Claim 8 has been amended so as to clarify this.

Claim Objections

Claims 9-10 were objected to under 37 CFR 1.75(c) as being in improper form because a multiple dependent claim cannot depend from any other multiple dependent claim. These claims have been amended herein, in order to correct the dependencies and thereby overcome the objection.

Prior Art Rejections

Claims 1 and 10 stand rejected under 35 U.S.C. §102 as anticipated by Armand et al. USP 6,514,640 ("Armand"), and claims 1-10 stand rejected under 35 U.S.C. §102 as anticipated by Hatta et al. CA 2456056 ("Hatta"). Claims 2-4 and 9 stand further rejected under 35 U.S.C. §103(a) as obvious in view of the combination of Armand with Armand et al. WO 02/27823A1. Claims 5-6 stand further rejected under 35 U.S.C. §103(a) as obvious in view of the combination of Armand with Armand et al. WO 02/27823, and further in view of Yamasaki et al. USP 5,888,671 and Shinozaki et al. USP 6,585,915. Claims 7-8 stand further rejected under 35 U.S.C. §103(a) as obvious in view of the combination of Armand with Armand et al. WO 02/27823, and further in view of Fujii et al. USP 4,740,437.

These rejections are respectfully traversed. It should be noted that, in the method for producing a cathode material for a secondary battery according to claim 1, the "metal iron" used in the step of "mixing a compound which releases phosphate ions in a solution with water and metal iron to dissolve the metal iron" does not include an iron element present in the form of an "iron-containing compound" such as iron acetate ($Fe(CH_3CO_2)_2$), for example. That is, the "metal iron" in the present invention does not include an iron element present in the form of any iron-containing compound formed by chemical bonding with other atoms or functional groups.

The "metal iron" in claim 1 means iron as metal proper, formed by mutual metallic bonding of iron atoms. That is, the "metal iron" means pure iron such as α-Fe (α-iron).

This can be understood, without any doubt, from the description of Example 1 (starting from page 21) and Example 2 in the specification of the present application, which clearly states that an 85% H_3PO_4 aqueous solution is added to <u>iron particles</u> (iron powder) as a raw material to cause a dissolution reaction therebetween while grinding them. The relevant text is as follows (with added emphasis):

" Example 1

(1) Preparation of cathode material:

A cathode material $LiFePO_4$ was synthesized by the following procedure.

A mixture of 4.5 g of <u>iron particles [under 325 mesh (44 μm) (purity 99.9%)</u>: <u>product of The Nilaco Corporation]</u> and 9.2901 g of 85% H_3PO_4 (product of Wako Pure Chemical Industries, Ltd.) was ground and reacted in an automatic grinding machine for two hours (when the viscosity of the mixture increased during grinding, distilled water was added to decrease the viscosity)."

By contrast with the claimed invention, all of the cited references disclose that an "iron compound" present in the form of a "compound" such as iron acetate ($Fe(CH_3CO_2)_2$) is used as a raw material for producing a cathode material for a secondary battery. Thus, the cited references neither teach nor suggest the present invention's use of the much less expensive (and also more desirable, for the reasons set forth immediately below) "metal iron" as a raw material.

The technical significance of using "metal iron," rather than an "iron compound," as a raw material for producing a cathode material for a secondary battery in the present invention can be understood from the section entitled "Background Art" (page 1-2) and the description of the function and effect of the invention of claim 1 (page 3, lines 1-10) of the specification. The relevant text is as follows (with added emphasis):

" Background Art

$LiFePO_4$ having an olivine-type (Pnma) crystal structure as a cathode material used in a secondary battery such as a metal lithium battery, lithium ion battery, or lithium polymer battery is subjected to electrode oxidation/reduction accompanied by doping/undoping of lithium during the process of charging and discharging.

* * *

"However, the starting materials used in the above methods (1) to (4) are all secondary compounds which are expensive and difficult to obtain. For example, Li_3PO_4 and iron oxalate (FeC_2O_4) are both relatively exp[e]nsive and cause an increase in the production costs of the cathode material. $Fe_3(PO_4)_2 \cdot 8H_2O$ as another iron compound can be synthesized from Na_2HPO_4 and $Fe(II)SO_4 \cdot 7H_2O$, for example, but it is a hydrate whose hydration number is unstable and it is therefore difficult to control the feeding of it in a stoichiometric manner. Also, since $Fe_3(PO_4)_2 \cdot 8H_2O$ is obtained as a precipitate in the synthesis process thereof, a cumbersome process such as filtering is required to remove sodium ions and so on. However, it is difficult to remove sodium ions and so on completely, and such a process may bring the entry of impurities. To

carry out the filtering completely to increase the purity of the calcination precursor, it is preferred to allow the crystals of $Fe_3(PO_4)_2 \cdot 8H_2O$ precipitates to grow until they reach a large diameter (about 10 μm or greater). However, when a mixture of $Fe_3(PO_4)_2 \cdot 8H_2O$ particles with a large diameter and Li_3PO_4 is calcined, the resulting $LiFePO_4$ particles have a large diameter and have low activity as a cathode material.

"As described above, the conventional techniques for producing $LiFePO_4$ <u>have problems of the entry of impurities and the necessity of a cumbersome process</u>. Also, <u>since primary materials which are inexpensive and easily available such as metal iron cannot be used</u>, <u>the cost is unavoidably high</u>. Thus, any of the conventional techniques is not satisfactory as a method for producing $LiFePO_4$ in an industrial scale.

"It is, therefore, an object of the present invention to provide a method for producing $LiFePO_4$ as a cathode material for a secondary battery reliably <u>from primary materials which are easily available and inexpensive</u>.

* * *

"According to the aspect, a cathode material for a secondary battery ($LiFePO_4$ as a cathode active material) can be produced directly <u>from metal iron</u> as a primary material <u>which is inexpensive and easily available</u> and phosphoric acid, lithium hydroxide or the like which are also inexpensive and easily available. Also, there is no need for a cumbersome process such as filtering of precipitate during the production process, and fine particles of a calcination precursor can be obtained directly from a stoichiometric mixture of the ingredients. Thus, the method of

the present invention is a production technique which is highly practical in the production of a cathode material for a secondary battery in an industrial scale."

Since the invention of independent claim 1 distinguishes patentably over the cited art for the reasons discussed above, the inventions of dependent claims 2, 3, and 5 to 10 similarly are patentable.

Conclusion

It is believed that all of the claims are in condition for allowance, which action is respectfully requested.

Respectfully submitted,

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